

REMARKS

In response to the above Office Action, claim 1 has been amended to more clearly define Applicants' invention. More specifically, claim 1 has been amended to limit the modified block co-polymer to a terminal-modified block copolymer (i.e., a block copolymer which comprises a base block copolymer and a modifier group bonded to a terminal of the base block copolymer) and the at least one functional group of the modifier group to one selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and an alkoxy silane group. Support for this amendment can be found at page 24, lines 9-20 and page 26, lines 4-9 of the specification. Conforming amendments have also been made to claims 2, 4, and 5.

With respect to claim 3, formulae (7), (11), and (12) have been amended to limit the groups represented by these formulae to ones having at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and an alkoxy silane group. More specifically, R⁵ in formula (7) has been limited to a group R⁷, which represents a C₁-C₄₈ hydrocarbon group having at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and a C₁-C₂₄ alkoxy silane group and R² in each of formulae (11) and (12) has been limited to a group R⁸, which represents a hydrogen atom or a C₁-C₂₄ hydrocarbon group.

New dependent claim 6 has been added to claim the feature that the modifier group is bonded to the at least one vinyl aromatic polymer block (A) of the base block copolymer of claim 1. Support for new claim 6 can be found at page 35, lines 14-16 of the specification.

It is not believed that any new matter is being introduced by these amendments, and their entry is therefore requested.

The state of the art and the essential features and advantages of the present invention

The following is submitted to show the development of the present invention and the advantageous features thereof.

As described in the specification under the section "Prior Art" beginning on page 2, due to the expansion of traffic and the increase in the number of expressways, there is a growing demand for an asphalt mixture (which is comprised of a plurality of aggregates and an asphalt composition as a binder) having excellent strength and excellent abrasion resistance. Also, there is a growing demand for an asphalt mixture which not only has excellent strength and excellent abrasion resistance, but also can be used to form a highly open graded pavement layer which can improve the drainage properties and noise reduction properties of expressways. To achieve these properties, it is desirable to develop an asphalt composition having a high softening point, high ductility, excellent storage stability at high temperatures, and excellent flexural properties at low temperatures and which can be advantageously used in road paving to form a pavement layer having excellent dynamic stability and excellent aggregate gripping properties.

In this situation, the present inventors have made extensive and intensive studies with a view toward developing an asphalt composition having the above mentioned properties. As a result, it has unexpectedly been found that such an asphalt composition can be realized by an asphalt composition as defined in amended claim 1.

Claim 1 relates to:

An asphalt composition comprising:

0.5 to 50 parts by weight of a block copolymer component (I) comprising at least one terminal-modified block copolymer comprising:

a base block copolymer comprising at least one vinyl aromatic polymer block (A) composed mainly of vinyl aromatic hydrocarbon monomer units and at least one conjugated diene polymer block (B) composed mainly of conjugated diene monomer units, and

a modifier group bonded to a terminal of said base block copolymer, said modifier group having at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and an alkoxysilane group,

said base block copolymer being unhydrogenated or hydrogenated, 100 parts by weight of an asphalt (II), and
0.01 to 10 parts by weight of at least one vulcanizing agent (III) selected from the group consisting of sulfur and a sulfur containing compound.

This asphalt composition contains, as a block copolymer component, a terminal-modified block copolymer which comprises a base block copolymer and a modifier group bonded to a terminal of the base block copolymer, wherein the modifier group has at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and an alkoxysilane group. By virtue of the use of such a terminal-modified block copolymer, the asphalt composition has a high softening point, high ductility, excellent storage stability at high temperatures and excellent flexural properties at low temperatures, and can be advantageously used in

road paving to form a pavement layer having excellent dynamic stability and excellent aggregate gripping properties.

A terminal-modified block copolymer is more advantageous than a main chain-modified block copolymer (wherein a “main chain-modified block copolymer” includes a graft-modified block copolymer). When the modifier group is bonded to a terminal of the base block copolymer (which has excellent rubber properties), the excellent rubber properties of the base block copolymer can be retained in the asphalt composition. Therefore, the asphalt composition is improved with respect to ductility, and flexural properties at low temperatures, and the dynamic stability of the pavement layer is improved when the asphalt composition is used to form the pavement layer. On the other hand, if the modifier group is not bonded to a terminal of the base block copolymer, but to a main chain thereof, the excellent rubber properties of the base block copolymer are not likely to be retained in the asphalt composition. Then the ductility and flexural properties of the asphalt composition and the dynamic stability of the pavement layer are not improved.

In addition, a modifier group having at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and an alkoxy silane group is more advantageous than a modifier group having a functional group other than those mentioned. When the modifier group is that claimed and is bonded to a terminal of the base block copolymer, the asphalt composition has a high affinity for aggregates, and interactions are caused between the terminal-modified block copolymer and the aggregates. Therefore, when the asphalt composition is used

in road paving to form a pavement layer, the aggregate-gripping properties of the pavement layer can be enhanced.

A terminal-modified block copolymer is obtained by reacting a living block copolymer with a modifier compound having or being capable of forming at least one functional group (see page 24, lines 9-20 of the specification). It should be noted that if, instead of a living block copolymer, a non-living block polymer is reacted with a modifier compound, a terminal-modified block copolymer is not likely to be obtained.

The excellent effects of the asphalt composition of the invention are shown in the working examples (i.e., Examples 1-7) (see pages 60-83 of the specification). It should be noted that Example 8 was amended to a comparative example (see the Preliminary Amendment filed March 29, 2005).

In each of Examples 1-7, there is produced a terminal-modified block copolymer which comprises a base block copolymer and a modifier group bonded to a terminal of the base block copolymer, wherein the modifier group has at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and an alkoxy silane group.

Each of Examples 1, 2 and 3 uses polymer 1 (see Table 1 appearing on page 80 of the specification). Examples 4, 5 and 6 use polymers 3, 4, and 5, respectively (see page 81, lines 15-19 of the specification). Further, Example 7 uses polymer 6 (see Table 3 appearing on page 83 of the specification). Therefore, the polymers used in the working examples (i.e., Examples 1-7) are polymers 1, 3, 4, 5, and 6. Each of these polymers is a terminal-modified block copolymer as defined in amended claim 1 of the application.

Polymer 1 is obtained by reacting a living polymer with 1,3 dimethyl-2 imidazolidinone (referred to as “modifier compound M1”) (see page 63, line 19 to page 65, line 1 of the specification). This modifier compound has an imino group as a functional group and, during the reaction of the living polymer with the modifier compound, the imino group is converted to an amino group. Therefore, polymer 1 is a terminal-modified block copolymer which has, bonded to a terminal thereof, a modifier group having an amino group.

Polymer 3 is obtained by reacting a living polymer with tetraglycidyl-1,3-bisaminomethylcyclohexane (referred to as “modifier compound M2”) (see page 65, line 16 to page 66, line 21 of the specification). This modifier compound has, as a functional group, an epoxy group and an amino group. Therefore, polymer 3 is a terminal-modified block copolymer which has, bonded to a terminal thereof, a modifier group having an epoxy group and an amino group.

Polymer 4 is a terminal-modified block copolymer which has, bonded to a terminal thereof, a modifier group having an amino group, because polymer 4 is produced by hydrogenating a polymer which is produced in substantially the same manner as in the production of polymer 1 (see page 67, lines 5-25 of the specification).

Polymer 5 is produced by hydrogenating a polymer which is obtained by reacting a living polymer with γ -glycidoxypropyltriethoxysilane (referred to as “modifier compound M3”) (see page 68, lines 6-25 of the specification). This modifier compound has, as a functional group, an epoxy group and an ethoxysilane group. Therefore, polymer 5 is a terminal-modified block copolymer which has, bonded to a terminal thereof, a modifier group having an epoxy group and an ethoxysilane group.

Polymer 6 is obtained by reacting a living polymer with the above-mentioned modifier compound M1 (i.e., 1,3-dimethyl 2 imidazolidinone) (see page 69, line 10 to page 70, line 25 of the specification). Therefore, polymer 6 is a terminal-modified block copolymer which has, bonded to a terminal thereof, a modifier group having an amino group.

Thus, each of polymers 1, 3, 4, 5, and 6 is a terminal-modified block copolymer which comprises a base block copolymer and a modifier group bonded to a terminal of the base block copolymer, wherein the modifier group has at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and an alkoxy silane group. It should be emphasized that the working examples of the application show that the use of such a terminal-modified block copolymer achieves the excellent effects of the asphalt composition of the present invention.

In the Office Action the Examiner rejected claim 1 under 35 U.S.C. 103(a) for being obvious over Gelles et al. (U.S. Patent 5,189,083), hereinafter “Gelles '083 or Kluttz (U.S. Patent 5,278,207), in view of JP-10-168323, hereinafter “JP '323. Specifically, as set forth in paragraph 4 of the Office Action, the Examiner argues that Gelles discloses a functionalized block copolymer and bitumen in claims 1-18 and crosslinking by sulfur in column 8, lines 16-20. Kluttz teaches a functionalized block copolymer and bitumen in claims 1-31 and crosslinking by sulfur in column 6, lines 50-53. While the primary references do not mention the concentration of the crosslinking agent, JP'323 shows in the Abstract the addition of 0.1-1.0% of sulfur to a bitumen/block copolymer blend. Therefore it would have been obvious to one having ordinary skill in

the art at the time the invention was made, to add the amount of sulfur suggested by the secondary reference to the compositions of the primary references, since this amount seems to be sufficient for vulcanizing the elastomer.

As discussed above, the asphalt composition of the present invention contains a terminal-modified block copolymer which comprises a base block copolymer and a modifier group bonded to a terminal of the base block copolymer, wherein the modifier group has at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and an alkoxysilane group. By virtue of the use of such a terminal-modified block copolymer, the asphalt composition of the present invention has a high softening point, high ductility, excellent storage stability at high temperatures, and excellent flexural properties at low temperatures, and can be advantageously used in road paving to form a pavement layer having excellent dynamic stability and excellent aggregate gripping properties.

On the other hand, as explained below, none of Gelles '083, Kluttz and JP '323 has any teaching or suggestion about such a terminal-modified block copolymer, and the effects achieved by its use.

Gelles '083 discloses a bituminous composition comprising a bituminous component and a functionalized block copolymer comprising at least one conjugated diolefin block and at least one acrylic monomer block, such as an alkyl methacrylate block (see claim 1 and column 2, lines 49-54 of Gelles '083).

The functionalized block copolymer used in Gelles is a main chain-modified polymer and does not have its terminal modified. This is apparent from the following descriptions in Gelles '083:

"Endcapping does not provide a high level of functional groups." (emphasis added) (see column 2, lines 37-38 of Gelles '083)

"The approach to prepare functionalized block copolymers for use in bituminous compositions described in the present invention is cost effective, gives a non-degraded product which incorporates the functional monomer as part of the polymer chain and lends itself to high and low molecular weight and non-hydrogenated and hydrogenated products." (emphasis added) (see column 2, lines 39-45 of Gelles '083)

In this connection, the following should be noted. In Gelles '083, the functionalized block copolymer can be subjected to acid functionalization (see column 4, lines 11-12 of Gelles '083). By acid functionalization, a functional group containing a carboxyl group is obtained. This functional group is different from the modifier used in the present invention, which is selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and an alkoxy silane group.

Therefore, it is apparent that Gelles '083 has no teaching or suggestion of the terminal-modified block copolymer as defined in the present invention, and the effects achieved by the use of it.

Kluttz discloses a bituminous composition comprising a bituminous component, a functionalized block copolymer and a polyfunctional amine, wherein the functionalized block copolymer comprises at least one conjugated diolefin block, at least one acrylic monomer block, and optionally at least one vinyl aromatic hydrocarbon block (see claims 1 and 2 of Kluttz). The functionalized block copolymer may have been subjected to acid or anhydride functionalization (see claim 16 of Kluttz) or may have grafted thereon at least one functional monomer (see claim 18 of Kluttz).

The functionalized block copolymer used in Kluttz, however, is a main chain-modified polymer and does not have its terminal modified. This is apparent from the following descriptions in Kluttz :

“ The polymer may be functionalized by incorporating therein at least one acrylic monomer block or the polymer may be functionalized by grafting onto the polymer backbone acid or anhydride groups.” (emphasis added) (see column 2, lines 40-43 in Kluttz);

“ In one preferred embodiment of the present invention, the bituminous composition contains a block polymer of at least one conjugated diene and at least one acrylic monomer

These polymers are functionalized in that they contain, in the polymer backbone, acrylic, especially methacrylate or acrylate, functionality.” (emphasis added) (see column 2, lines 51-67 of Kluttz).

Therefore, it is apparent that Kluttz has no teaching or suggestion of the terminal-modified block copolymer as defined in the present invention, and the effects achieved by the use of it.

While JP '323 may disclose the addition of a specific amount of sulfur to a bitumen/copolymer blend, the reference has no teaching or suggestion about a terminal-modified block copolymer as defined in the present invention, and the effects achieved by the use of it.

As noted in M.P.E.P. §2142, to establish a prima facie case of obviousness, it is necessary that the Examiner clearly set forth the reasons why the claimed invention would have been obvious. Examples (A)-(G) are ways to support a conclusion of obviousness as set forth in M.P.E.P. §2143. It is submitted that none of these Examples have been met by the currently cited combination of references. For example, none of the cited references relied on discloses or even remotely suggests the terminal-modified block copolymer as defined in the present invention

[M.P.E.P. §2143 (G)] or the effects achieved by the use of it in an asphalt composition [M.P.E.P. §2143 (A)].

Withdrawal of Gelles or Kluttz in view of JP'323 as a ground of rejection of the claims under §103(a) is therefore requested.

The Examiner also rejected claims 1-5 under 35 U.S.C. 103(a) for being obvious over Gelles '220 or Ohtsuka, in view of Maldonado '322, Maldonado '246, Hagenbach, Duong, Chaverot, Planche '162, Planche '112, GB '344 or JP '323. These are the references cited in the International Preliminary Examination Report.

As mentioned above, the asphalt composition of the present invention contains a terminal-modified block copolymer which comprises a base block copolymer and a modifier group bonded to a terminal of the base block copolymer, wherein the modifier group has at least one functional group selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and an alkoxy silane group. By virtue of the use of such a terminal-modified block copolymer, the asphalt composition has a high softening point, high ductility, excellent storage stability at high temperatures, and excellent flexural properties at low temperatures, and can be advantageously used in road paving to form a pavement layer having excellent dynamic stability and excellent aggregate-gripping properties.

On the other hand, as mentioned below, none of Gelles '220, Ohtsuka , Maldonado '322, Maldonado '246, Hagenbach , Duong , Chaverot , Planche '162, Planche '112, GB '344 and JP '323 has any teaching or suggestion about such a terminal-modified block copolymer, and the effects achieved its use.

Gelles '220 discloses a bitumen emulsion comprising bitumen, water, a functionalized block copolymer, and optionally at least one emulsifier, wherein the functionalized block copolymer contains functional groups which have a strong affinity for water, and is comprised of at least one conjugated diene block and at least one acrylic monomer block (see claim 1 of Gelles '220). The functional groups which have a strong affinity for water are bonded to acrylic monomers contained in the acrylic monomer block (see column 2, lines 12-17 of Gelles '220).

The functionalized block copolymer used in Gelles '220 is a main chain-modified polymer and does not have its terminal modified. This is apparent from the following description of Gelles '220:

“ These polymers are block copolymers of at least one conjugated diene and at least one acrylic monomer . . .
These polymers are functionalized in that they contain, in the polymer backbone, acrylic, especially methacrylate or acrylate, functionality.” (emphasis added) (see column 4, lines 32-47 of Gelles '220)

Therefore, it is apparent that Gelles '220 has no teaching or suggestion of the terminal-modified block copolymer as defined in the present invention, and the effects achieved by the use of it.

Ohtsuka discloses a curable composition comprising a functionalized block copolymer, asphalt mixed with tar, and a curing agent, wherein the functionalized block copolymer is an epoxy-modified diene-based block copolymer containing a polymer block consisting of an aromatic vinyl compound and a polymer block consisting of a compound having a conjugated double bond, in which unsaturated double bonds are partially epoxidized (see claim 1 of Ohtsuka).

This epoxy-modified diene-based block copolymer used in Ohtsuka is a main chain-modified polymer and does not have its terminal modified, since the epoxidization in the epoxy-modified diene-based block copolymer is effected in unsaturated double bonds contained in the conjugated diene block of the main chain of the copolymer.

Therefore, it is apparent that Ohtsuka has no teaching or suggestion of the terminal-modified block copolymer as defined in the present invention, and the effects achieved by the use of it.

Maldonado '322 discloses a bitumen-polymer composition containing a block copolymer comprising diene and styrene groups (see ABSTRACT of Maldonado '322). However, Maldonado '322 has no teaching or suggestion of the terminal-modified block copolymer as defined in the present invention, and the effects achieved by the use of it.

Maldonado '246 discloses a polymeric bitumen which is obtained by using a petroleum fraction, a copolymer made of styrenic blocks and dienic blocks, crystallized sulfur and a bitumen (see ABSTRACT of Maldonado '246). However, Maldonado '246 has no teaching or suggestion of the terminal-modified block copolymer as defined in the present invention, and the effects achieved by the use of it.

Hagenbach discloses a bitumen-polymer composition which is obtained by using a bitumen, a styrene/conjugated diene copolymer and a sulfur source (see ABSTRACT of Hagenbach. However, Hagenbach has no teaching or suggestion of the terminal-modified block copolymer as defined in the present invention, and the effects achieved by the use of it.

Duong discloses an asphalt composition comprising an asphalt, a synthetic or natural rubber and elemental selenium or an organo-selenium (see ABSTRACT and

claim 1 of Duong). However, Duong has no teaching or suggestion of the terminal-modified block copolymer as defined in the present invention, and the effects achieved by the use of it.

Chaverot discloses a bitumen/polymer component comprised of a hydrocarbon matrix in which a sulfur-crosslinked elastomer is distributed homogeneously (see claim 1 of Chaverot). The sulfur-crosslinked elastomer can be a sulfur-crosslinked copolymer of styrene and a conjugated diene (see claim 4 of Chaverot). However, Chaverot has no teaching or suggestion of the terminal-modified block co-polymer as defined in the present invention, and the effects achieved by the use of it.

Planche '162 discloses a functionalized elastomer/bitumen composition which is obtained by using at least one bitumen, an elastomer and a functionalization agent having, as an functional group, a carboxyl group (-COOH) or a carboxyl acid ester group (-COOR), and a sulfide group (-SH) (see claim 1 of Planche '162). The functionalized elastomer/bitumen composition contains a functionalized elastomer.

It is believed that the functionalized elastomer is not a terminal-modified elastomer, but a main chain-modified elastomer, because the functionalized elastomer is produced by reacting a non-living polymer with a functionalization agent. The use of a non-living polymer in Planche '162 is apparent from the following description of Planche '162:

“ The bitumen or mixture of bitumens is advantageously brought into contact with the elastomer, the functionalization agent . . . , by first of all incorporating the elastomer in the bitumen or mixture of bitumens . . . in order to form a homogeneous mixture of bitumen and of elastomer, by then introducing the functionalization agent into the said mixture . . . (emphasis added) (see column 4, lines 40-55 of Planche '162)

Also, it should be noted that the functional groups contained in the functionalized elastomer are different from the functional groups contained in the modifier used in the present invention, which is selected from the group consisting of a hydroxyl group, an epoxy group, an amino group, a silanol group and an alkoxy silane group.

Therefore, it is apparent that Planche '162 has no teaching or suggestion of the terminal-modified block co-polymer as defined in the present invention, and the effects achieved by the use of it.

Planche '112 discloses a bitumen-polymer composition which is obtained by using bitumen, a block copolymer of styrene and a conjugated diene, and a coupling agent containing a sulfur-donor compound (see ABSTRACT of Planche '112). However, Planche '112 has no teaching or suggestion of the terminal-modified block copolymer as defined in the present invention, and the effects achieved by the use of it.

GB '344 discloses a bitumen/styrene-butadiene copolymer composition which is obtained by using a bitumen fluxed with a petroleum, a styrene-butadiene copolymer, sulfur, and a light fluxant (see claim 1 of GB '344). However, GB '344 has no teaching or suggestion of the terminal-modified block co-polymer as defined in the present invention, and the effects achieved by the use of it.

JP '323 discloses, as mentioned above, the addition of a specific amount of sulfur to a bitumen/copolymer blend. However, the reference has no teaching or suggestion of the terminal-modified block copolymer as defined in the present invention, and the effects achieved by its use.

From the above, it is apparent that none of Gelles '220, Ohtsuka , Maldonado '322 , Maldonado '246, Hagenbach, Duong, Chaverot , Planche '162, Planche '112,

GB'344 and JP '323 has any teaching or suggestion about the present invention. Accordingly, for the same reasons expressed above with respect to the first ground of rejection, it is believed the Examiner has not established a *prima facie* ground of obviousness based on this combination of references. Withdrawal of this combination of references as a ground of rejection of the claims under §103(a) is therefore requested.

It is believed claims 1-6 are now in condition for allowance.

In view of the foregoing amendments and remarks, Applicants respectfully request reconsideration and reexamination of this application and the timely allowance of the pending claims.

Please grant any extensions of time required to enter this response and charge any additional required fees to our deposit account 06-0916.

Respectfully submitted,

FINNEGAN, HENDERSON, FARABOW,
GARRETT & DUNNER, L.L.P.

Dated: October 25, 2007
By: 
Arthur S. Garrett
Reg. No. 20,338
Tel: 202 408-4091